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SHORTER ARTICLES AND DISCUSSION

THE PROBABLE ORIGIN OF THE CRINOIDAL NERVOUS SYSTEM

ALTHOUGH at first sight the nervous system of a crinoid appears to be so radically different from that of an invertebrate of the more usual bilateral type that no satisfactory comparison is possible between them, I believe that there is no difficulty at all in deriving it from the latter.

The nervous system of a crustacean, worm or insect consists typically of a supracæsophageal ganglion united by a pair of circumcæsophageal ganglionic connectives to a more or less marked subcæsophageal ganglion, from which there runs back along the ventral side of the animal a long nerve cord, or pair of nerve cords, marked at intervals with ganglia. The anterior end of the digestive tube passes between the two chief ganglionic masses, as the names of all these structures indicate.

The ancestral crinoid was bilateral, and therefore possessed a nervous system constructed according to this plan. With the progressive decrease in directive locomotion the ventral nerve cord was correspondingly shortened, concurrently with the assumption by the animal of a more compact form, just as the nerve cord has been shortened in *Cancer* as compared with *Palinurus*, in *Dynamine* as compared with *Apseudes*, in *Cimex* as compared with *Diapheromera*, or, better, in the crustaceans as a class as compared with the annelids as a class. In the crinoids the shortening progressed still further; locomotion, other than casual or accidental, ceased; the anterior end of the intestinal canal became deflected upward and pressed upon the anterior part of the supracæsophageal ganglion which gave way before it and became deeply crescentic; at the same time the ventral nervous cord was retracted into a short protuberance from the subcæsophageal ganglion. Finally the horns of the crescent formed from the supracæsophageal ganglion met in front of the throat so that what was originally a ganglion mass became a nerve ring, the two connectives became broken up into numerous connecting fibers, and the whole ventral nerve cord with its

ganglia became retracted into the subœsophageal ganglion, now become the dorsal nerve mass.

Thus we may very easily derive the radiating nervous system of the crinoid from the bilateral nervous system of the arthropod, the circumoral nerve ring of the crinoid being derived from the supraœsophageal ganglion of the arthropod, and the dorsal nervous system from the subœsophageal ganglion. In this connection it is significant that the circumoral nerve ring innervates the same structures and possesses the same functions as the supraœsophageal ganglion, while the dorsal nervous system is identical with the subœsophageal ganglion, plus the ventral nerve cord, in the nature of its duties.

The assumption of the pentaradiate form by the crinoids has produced a complex condition of orientation; for the so-called "ventral" surface of the crinoid, in terms of arthropod or annelidan orientation, is equal to the anterior end, plus the posterior end, and plus such part of the dorsal surface as is not shoved to one side by the approximation of the two extremities of the intestinal canal; while the "dorsal" surface of the crinoid is the equivalent of the entire *ventral* surface of the arthropod, plus more or less, possibly nearly all, of the dorsal surface.

AUSTIN H. CLARK.